Summer 1960

Seasonal Movement and Activity of Small Rodents in Four Different Ecological Areas

Merrill Frydendall
Fort Hays Kansas State College

SEASONAL MOVEMENT AND ACTIVITY OF SMALL RODENTS IN FOUR DIFFERENT ECOLOGICAL AREAS

being

A Thesis presented to the Graduate Faculty of
Fort Hays Kansas State College in
partial fulfillment of the requirements for
the Degree of Master of Science

by

Merrill Frydendall

Date 7/15/60 Approved D. W. Tomanek
Major Professor

Ralph V. Coder
Chairman, Graduate Council

THESIS ABSTRACT

Frydendall, Merrill. 1960. Seasonal movement and activity of small rodents in four different ecological areas.

This investigation was conducted in the mixed-prairie association near Hays, Kansas. The principal purpose was to study seasonal movement, activity and species composition of small rodents in four different ecological areas. These four different habitats were: a non-grazed prairie, commonly referred to as the relict area; a moderately grazed pasture; a shelterbelt; and a streambank association.

Live trapping was used in all four areas so that individuals could be captured, marked, released and recaptured to obtain the data desired. With the use of live traps the biota was only slightly disturbed and data was gathered which would have been impossible to obtain with snap-traps.

Eight species of small rodents were recorded in this investigation. These were: prairie deer mouse (Peromyscus maniculatus luteus); hispid cotton rat (Sigmodon hispidus texianus); western harvest mouse (Reithrodontomys megalotis duchei); prairie vole (Microtus ochrogaster haydeni); thirteen-lined ground squirrel (Spermophilus tridecemlineatus arenicola); white-footed mouse (Peromyscus leucopus aridulus); coarse-haired pocket mouse (Perognathus hispidus paradoxus); and house mouse (Mus musculus). Of these eight species seven had been previously reported from this area. The white-footed mouse was first captured in this area during this investigation.

In all four ecological areas under investigation it was found that the small mammals were most abundant during the summer season. In all areas except the moderately grazed pasture there was a decrease in the populations of the small rodents during the fall and a low was reached during the winter and early spring. The populations of the moderately grazed pasture remained more or less constant, with only minor fluctuations, throughout all four seasons. On the shelterbelt and streambank trapping areas there was no spring increase in the abundance of the small mammals from the winter low. This was probably due to snow which remained on these two areas from the middle of January to the last of March. Snow remaining on the ground for such a length of time would possibly eradicate many individuals through exposure, and cause them to die of starvation.

Considerable information was recorded in regard to seasonal activities and species composition but only meager information on seasonal movements was obtained.

ACKNOWLEDGMENTS

The author is indebted to Dr. E. P. Martin for his suggestion in the choice of this problem and for advice during research and to Dr. G. W. Tomanek for criticizing the manuscript. The author also wishes to express thanks to his wife, Karen, for help in tabulating data and preparing this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Small rodents do very little damage to the prairie vegetation. However, over a period of years considerable vegetation will be consumed by these mammals. If in the future all vegetation would be needed to sustain the human population an investigation such as this would be valuable in controlling small rodents.

The four different ecological areas used for this investigation were located in the mixed prairie association, near Hays, Kansas.

The mixed prairie association, bordered by the true prairie on the east and the short grass plains on the west, contains numerous habitats. These habitats vary from the short grass communities found in the more xeric areas to the wooded post-climax communities located mainly along the streams.

The foundation for ecological studies, especially near Hays, Kansas, was provided by Albertson (1937) and later studies by him (1938, 1939, 1943, 1945) added still further data. Studies by Albertson and Weaver (1942), Hopkins, et al. (1952), Tomanek and Albertson (1953) and Weaver and Albertson (1956) provided further information valuable to ecological investigations in this area. Pertinent zoological publications of this area were those of Allen (1940), Black (1937), Brown (1945, 1946, 1947), Cockrum (1952), Hall (1955), Hibbard (1944), Martin (1960), Riegel (1941, 1942) and Wooster (1931, 1935, 1936, 1938, 1939).

The purpose of this investigation was to study seasonal changes of distribution, activity and species composition of small mammals on selected sites near Hays, Kansas. Life history studies of the species of small ro-

dents captured were used to aid in explaining the data collected. Other purposes of this study were to provide a basis for further consideration and to acquire skill in ecological investigation.

METHODS

The principal method used to study the abundance and distribution of small mammals of the four ecological areas was live trapping. Traps used in the relict area (ungrazed prairie) were similar to those described by Fitch (1950). Traps used in the other three areas (shelterbelt, streambank association and moderately grazed pasture) had a larger runway which was inserted into a number five can rather than being attached to a number ten can (Fig. 1). Dice (1931) discusses the advantages and disadvantages of live trapping in studying the distribution and abundance of small mammals. Live traps are more effective in trapping small mammals without injury, and disturb the biota less than snap-trapping (Cockrum, 1947). During the winter months cotton was placed in the traps to aid in protecting the captured mammals from the cold. Bait used was scratch grain, purchased at a local elevator.

In all four areas traps were set in a grid fashion. Due to the varying sizes of the habitats, however, different distances between grid lines were used.

Individuals captured were marked by toe clipping for future identification and released (Fitch, 1952). Pertinent data were recorded on cards, with a separate card for each individual.

Traps were in operation from six to eight consecutive days of each month of the study period (July 1959 through May 1960). However, due to inclement weather no trapping was accomplished in January. Due to the drifting of snow it was impossible to operate the traps on the streambank association and shelterbelt trapping areas in either February or March.

Fig. 1. Modification of live trap described by Fitch (1950), used on the streambank association, shelterbelt and moderately grazed pasture trapping areas.

Habitat preferences were analyzed by testing the hypothesis of random distribution; significant deviations were interpreted as positive or negative preferences. Centers of activity were used to distinguish the community in which the small mammals were found.

Basal cover and composition of the grassy vegetation of the relict area and moderately grazed pasture were determined by the point system (Coupland, 1950; Clarke et al., 1942). Other non-grassy vegetation was estimated for frequency and abundance as described by Weaver and Fitzpatrick (1934). On the shelterbelt and streambank association frequency and abundance of all vegetation was estimated as described by Weaver and Fitzpatrick (1934).

The trapping period was divided into four seasons, as follows: spring - February, March and April; summer - May, July, August and September; fall - October and November; winter - December and January. These divisions were based on the patterns of vegetative growth and patterns of variation of climatic factors.

Nomenclature for broad leaved herbaceous vegetation follows Rydberg (1932) while grassy vegetation follows Hitchcock and Chase (1950). Nomenclature for trees follows Dickens et al. (1928) and mammals, Hall (1955).

CLIMATOLOGICAL DATA

The portion of the mixed prairie in which this investigation was conducted is located in the 20 to 25 inch rainfall belt.

Data used in compiling this section were obtained from the Hays section of the Kansas Climatological Data (1959 and 1960).

During the investigation period, July 1959 through May 1960 with the exception of January 1960, a total of 21.85 inches of precipitation was received, showing a deviation from the normal of 3.88 inches for this period of time (Table I). Of the total precipitation only 9.94 inches came during the days in which the traps were in operation.

From November 1959 through March 1960 a total of 41.0 inches of snow was received (Table II). Of this total 31.5 inches were received in the months of February and March, with only 9.5 inches being recorded for the other three months. During February and March there was a continuous period of 36 days, from February 20 to March 26, in which there was a cover of snow on the ground. Also, with the exception of one day, February 19, there was a span of 46 continuous days in which snow remained on the ground. During this time the depth of the snow ranged from a trace to 20.5 inches.

The minimum and maximum temperatures are given in Table III for the days in each month that the traps were in operation. The hottest days during the trapping period were August 21 and 22, when the maximum temperature reached 100° Fahrenheit. The coldest days, while the traps were in operation, were recorded in November. On November 14 the minimum temperature was one degree below zero Fahrenheit. On two other days, November 15 and 17, minimum temperatures recorded were one degree above zero Fahrenheit. August was the month in which the highest average minimum and maximum

Table I. Amount of precepitation received during trapping days and totals and departures from the meam for the month. Amounts given in inches.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May
Day										
1									.37	0
2										0
3										0
4										0
5										.67
6							0			
7							0			
8					0		0			
9					0		0		0	
10	0				0		.17		0	
11	.01			0	0		0		0	
12	.17			0	0		0		0	
13	0			T	T				.25	
14	1.05			0	0				0	
15	.01			0	0				0	
16	0		0	0	0					
17	0		.04	0	0					
18		0	2.16	0	0	0				
19		0	0	0	0	0				
20		0	0	0	0	0				.13
21		0	.89	0	0	0				.16
22		0	0	0		0				0
23		0	.30	T		0				0
24		.04	.44	0						0
25		.97	.21							.98
26			T					0		.03
27			0					0		
28			0					0		
29			0					.05		
30								0	.84	
31								0		
Total	3.62	2.25	4.96	3.73	0.03	0.17	1.21	0.94	2.34	2.87
Dep. from mean	1.07	-.67	2.48	2.51	-.91	-.43	.53	-.20	.41	-.91
Total inches of precepitation										21.85
Total departure from the mean										3.88

Table II. The amount of snow received during the winter, also showing the accumulative amounts of snow on the ground. Amounts are shown as: A - accumulation and D - daily amounts, given in inches.

Month / Day	Nov.		Dec.		Jan.		Feb.		Mar.	
	D	A	D	A	D	A	D	A	D	A
1									3.0	15.5
2									5.0	20.5
3										13.0
4										13.0
5	T									13.0
6										13.0
7										11.5
8										11.5
9										10.5
10							1.0	1.0		10.0
11								1.0		10.0
12								1.0		9.0
13								0.5		7.0
14								T	2.0	9.0
15					1.5	1.5	2.0	2.0	2.0	10.0
16						1.5		1.0	4.0	14.0
17					5.0	6.5		0.5		14.0
18					1.5	8.0		T		12.0
19						8.0				9.0
20						8.0	1.0	1.0		8.0
21						8.0	5.0	6.0		7.5
22						8.0		6.0		5.0
23					T	8.0	5.0	11.0		3.5
24						8.0		11.0		2.0
25						7.0		11.0		1.0
26						6.0		11.0		T
27			1.0	1.0		5.0		11.0		
28	.5	.5				5.0	1.0	12.0		
29						3.0	0.5	12.5		
30						2.0				
31						T				
Total In.	.5		1.0		8.0		15.5		16.0	41.0

Table III. Daily minimum and maximum temperatures for days traps were in operation and average minimum and maximum temperatures for the months during the investigation. Figures are given in degrees Fahrenheit.

Month	July		Aug.		Sept.		Oct.		Nov.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Day										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10	84	54								
11	87	55					60	35		
12	88	61					57	36		
13	83	63					70	39	52	25
14	82	62					58	39	59	29
15	82	66					69	42	70	33
16	78	60			88	50	83	46	67	33
17	82	67			67	51	62	29	47	33
18			96	70	58	50	59	33	46	15
19			97	70	70	55	73	36	20	-1
20			96	74	88	66	80	39	28	1
21			100	74	90	61	71	43	43	9
22			100	72	89	62	73	50	18	1
23			94	69	76	54	67	49	41	8
24			95	67	72	55	67	39	64	21
25					70	53			45	22
26					79	53			58	25
27					72	48				
28					79	51				
29					67	44				
30										
31										
Ave.	86.7	61.6	95.2	68.1	80.8	53.5	64.1	39.1	51.0	20.6

Table III. (Cont.)

Month	Dec.		Feb.		Mar.		Apr.		May	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Day										
1							75	33	57	35
2									69	44
3									73	52
4									76	55
5									69	52
6			47	27						
7			47	26						
8			59	33						
9			56	37			62	37		
10			38	17			60	34		
11			25	8			81	40		
12			24	8			71	47		
13							73	51		
14							69	41		
15							73	45		
16										
17										
18										
19	53	20								
20	43	21							69	46
21	38	22							67	41
22	49	16							77	50
23	47	16							88	65
24	33	17							85	63
25									91	55
26					61	30			78	47
27					75	37				
28					75	46				
29					82	49				
30					55	31	47	32		
31					69	40				
Ave.	49.3	23.3	31.7	13.5	38.3	19.3	69.2	42.3	73.3	48.1

temperatures were recorded. During August the average maximum temperature was 95.2° and the average minimum temperature was 68.1° Fahrenheit. February was the month in which the lowest average minimum and maximum temperatures were recorded. The average maximum temperature for February was 31.7° Fahrenheit and the average minimum temperature was 13.5° Fahrenheit.

DESCRIPTION OF AREAS

Relict Area

The relict area was an ungrazed prairie of approximately 35 acres lying 1.5 miles southwest of Hays, Kansas. The legal description is the southwest one-quarter of the south one-half of section 21, T-13S, R-18W. This prairie has belonged to Fort Hays Kansas State College since 1902 and before this was part of the Fort Hays Military Reservation. The area has been undisturbed for approximately 58 years, except for sporadic grazing, since the disappearance of the native ungulates.

The trapping plot located within the relict area was 1,000 feet long and 250 feet wide, taking in an area of approximately 5.73 acres (Fig. 2). Here there were five lines of traps, each line containing 20 traps, set in a grid with 50-foot intervals.

Within the trapping area five communities were identified on the basis of their grassy composition. These were big bluestem, little bluestem, western wheatgrass, mixed-grass, and weed communities.

The big bluestem community was located on the upper hillsides of the area and covered approximately 1.59 acres (Fig. 3). The basal cover of the big bluestem community was 11.4 per cent. Big bluestem (Andropogon gerardi) was dominant in this community; its frequency was 51.7 per cent and it made up 60.3 per cent of the grassy vegetation. Little bluestem (Andropogon scoparius) had a frequency of only 4.5 per cent but comprised 12.8 per cent of the composition. Other grasses, of which each made up approximately 10 per cent of the composition, were side-oats grama (Bouteloua curtipendula) and blue grama (Bouteloua gracilis).

Fig. 2. View of the relict area trapline from the western end. In the foreground is a small western wheatgrass community. Below the western wheatgrass is the mixed community. The weedy draw can be seen bisecting the trapline.

Fig. 3. Big bluestem community in the immediate foreground. A small patch of switch grass (Panicum virgatum) can be seen in the middle left-hand side of the photograph. A live trap is pictured in the near middle of the picture.

In the big bluestem community there were listed 77 species of non-grassy vegetation. The species found most abundantly over the entire community were wild alfalfa (Psoralea tenuiflora), lead plant (Amorpha canescens) and soapweed (Yucca glauca).

A small area of 0.24 acres located on a rocky break on a west-facing slope was designated as the little bluestem community (Fig. 4). The basal cover of this community was 14.7 per cent. Little bluestem was the dominant grass. Its frequency was 47.5 per cent and it made up 61.4 per cent of the grassy composition. Big bluestem, with a frequency of 25.8 per cent, made up 19.8 per cent of the composition and the remaining percentage of the composition was composed of side-oats grama and blue grama.

Within the little bluestem community 44 species of non-grassy vegetation were identified. Of these 44 species, snake root (Echinacea angustifolia), rigid-leafed goldenrod (Solidago rigida), sensitive briar (Morongia uncinata) and serrate-leafed evening primrose (Meriolix serrulata) were most common.

The western wheatgrass community, lying across the bottom of a west-facing slope, occupied an area of 0.69 acres (Fig. 5). This community had a basal cover of 12.8 per cent and was dominated by western wheatgrass (Agropyron smithii), with a frequency of 48.0 per cent. It made up 53.1 per cent of the grassy composition. Other grasses of importance in this community were blue grama, with a frequency of 10.0 per cent, producing 14.1 per cent of the composition and buffalo grass (Buchloe dactyloides), making up 20.3 per cent of the composition and having a frequency of 20.0 per cent.

Fig. 4. Little bluestem community on the break. Rocky break and open cover can be seen in the upper one-quarter of the photograph. On the left-hand side is a portion of the mixed-grass community.

Fig. 5. Western wheatgrass community, lying across the bottom of a west-facing slope. Some side-oats grama (Bouteloua curtipendula) can be seen in the foreground.

In this community 47 species of non-grassy vegetation were recorded. Those found most commonly were: wild alfalfa, Missouri goldenrod (Solidago glaberrima), western ragweed (Ambrosia psilostachya) and many-flowered aster (Aster multiflorus).

The largest portion of the trapping area, 2.29 acres, was the mixed-grass community, lying on the east and west-facing slopes (Fig. 6). The basal cover of this community was 13.9 per cent. Big bluestem, having a frequency of 41.7 per cent and producing 47.8 per cent of the composition, and little bluestem, with a frequency of 37.2 per cent, making up 34.7 per cent of the composition, were the two major grasses of this community. Other grassy vegetation of lesser composition, but of importance, were side-oats grama, blue grama, western wheatgrass and switch grass (Panicum virgatum).

Ninety-four species of non-grassy vegetation were listed in the mixed-grass community. Of these 94 species seven were most common: lead plant, wild alfalfa, sensitive briar, western ragweed, many-flowered aster, wavy-leafed thistle (Cirsium undulatum), and annual sunflower (Helianthus annuus).

The remaining 0.92 acres of the study acres was the weed community (Fig. 7). This community lay in a draw which bisected the trapping area. It was once a typical lowland community (Albertson, 1937) but, due to the dusting of 1930's and breaking of a pond dam in an adjacent pasture in 1951 which was not repaired for several years, the area was heavily silted. As a result a weed community developed. Since the repair of the pond dam, however, typical lowland grasses are moving back, progressively decreasing the size of the weed community.

Fig. 6. Mixed-grass community, lying on an east-facing slope. Big bluestem (Andropogon gerardi) and side-oats grama (Bouteloua curtipendula) can be seen in the foreground. Bunches of little bluestem (Andropogon scoparius) are visible on the central left hand side of the photograph. A patch of switch grass (Panicum virgatum) can be seen in the upper left-hand corner.

Fig. 7. Weed community lying in the draw bisecting the trapping area. Switch grass (Panicum virgatum) is visible under the upper layer of dead annual sunflower (Helianthus annuus) stalks.

Basal cover of this area was only 5.2 per cent. Big bluestem, with a frequency of 16.0 per cent, made up 48.1 per cent of the composition and western wheatgrass, having a frequency of 13.0 per cent, produced 30.8 per cent of the composition. Other grasses of importance were switch grass, tall dropseed (Sporobolus asper) and plains bluegrass (Poa arida). However, the most abundant grass was the weedy annual, Japanese brome (Bromus japonicus).

Fifty species of non-grassy vegetation were recorded in this community. The most important of these were: western ragweed, annual sunflower, giant ragweed (Ambrosia trifida), purple poppy mallow (Callirrhoe involucrata), iron weed (Vernonia baldwini), and wild lettuce (Lactuca ludoviciana).

Streambank Association

The streambank trapping area was located on Big Creek, just west of the Fort Hays Kansas State College campus (Fig. 8). The legal description is the southeast one-fourth of the south one-half of section 14, T-13S, R-18W.

This area showed a more or less three-layered habitat, with tall trees producing the upper layer, taller forbs such as the annual sunflower making up the middle story, and grassy vegetation such as Japanese brome filling in the lower layer (Fig. 9).

Due to the small size of the area, only 20 live traps were set in a grid. The rows were 25 feet apart and the traps were set at 50-foot intervals.

The dominant trees on this area were box elder (Acer negundo) and green ash (Fraxinus lanceolata). However, these were small in stature.

Fig. 8. View of the streambank trapping area on the far side of the creek. Big trees in the foreground are American elm (Ulmus americana).

Fig. 9. Streambank trapping area, showing the three-layered vegetation. The trees pictured are honeylocust (Gleditsia triacanthos); the taller forbs at the bottom of the picture are giant ragweed (Ambrosia trifida); the grassy vegetation in the lower left-hand corner is Mexican muhly (Muhlenbergia mexicana).

The greatest portion of the canopy was formed by American elm (Ulmus americana) and Honeylocust (Gleditsia triacanthos). Other woody vegetation was mulberry (Morus rubra) and wild grape (Vitis vulpina).

The most abundant forbs were fireweed (Kochia scoparia), giant ragweed, tall dock (Rumex altissimus) and maple-leafed goosefoot (Chenopodium gigantospermum). Other forbs which were not as abundant but afforded some cover and possibly food for the small rodents were annual sunflower, late flowering goldenrod (Solidago serotina), climbing false buckwheat (Polygonum scandens), mule's tail (Leptilon canadense), wild gourd (Pepo foetidissimus) and rosinweed (Silphium integrifolium).

Grasses dominant in this area were Canada wild rye (Elymus canadensis) and Mexican muhly (Muhlenbergia mexicana). Other grassy vegetation included western wheatgrass, Japanese brome and green foxtail (Setaria viridis).

Shelterbelt

The shelterbelt used in this investigation was located on the Fort Hays Kansas State College farm, near the maintenance building, one-half mile west of Hays, Kansas (Fig. 10). The legal description of this area is the southeast one-fourth of the south one-half of section 15, T-13S, R-18W.

The area between the rows of trees was disced during the summer of 1958, producing a situation where there were many early stage succession grasses and forbs growing. The north one-half of the trapping area had grown up to a heavy stand of weedy forbs (Fig. 11), while the south one-half of the trapping area was clear of heavy weedy growth (Fig. 12).

Fig. 10. Distant view of the shelterbelt trapping area. Darker trees are eastern red cedar (Juniperus virginiana) and the tall trees are Chinese elm (Ulmus parvifolia).

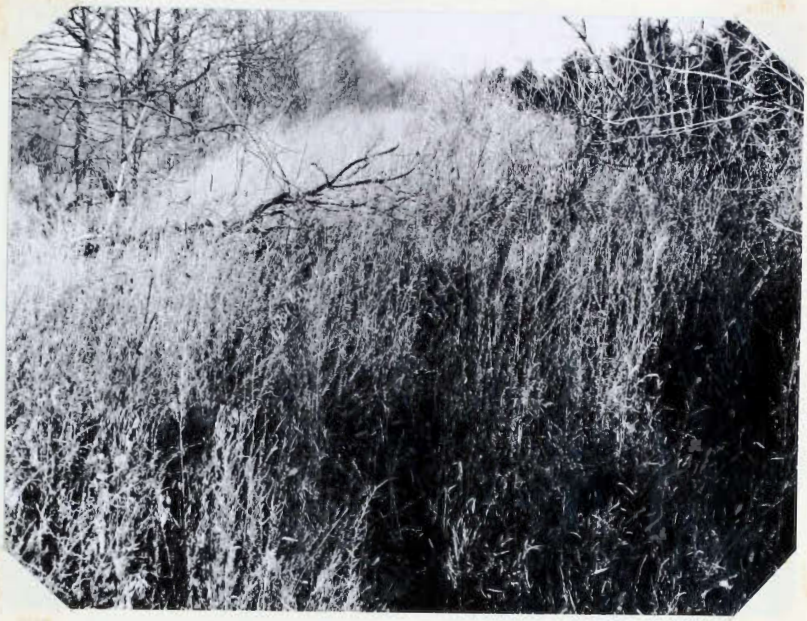

Fig. 11. Inside view of the north end of the shelterbelt, showing the heavy growth of annual grasses and weeds. Green foxtail (Setaria viridis) can be seen in the foreground. Trees on the left are honeylocust (Gleditsia triacanthos) and the tree on the right is Russian olive (Elaeagnus angustifolia).

Fig. 12. Inside view of the south end of the shelter-belt, showing the small amount of annual grasses and weeds. Trees on the right are Chinese elm (Ulmus parvifolia) and those on the left are Russian olive (Elaeagnus angustifolia).

The shelterbelt contained five rows of trees. There were one row of tamarix (Tamarix pentandra), one row of a mixture of honeylocust and Chinese elm (Ulmus parvifolia), one row of Russian olive (Elaeagnus angustifolia) and two rows of eastern red cedar (Juniperus virginiana).

In this trapping area there were 50 live traps. Due to the width of the shelterbelt the rows were set 25 feet apart and the traps were spaced at 50-foot intervals. One line of traps was located in the row of trees containing honeylocust and Chinese elm and the other line of traps was located in the inner row of the eastern red cedars.

A total of 17 species of grasses was recorded on the area. Most of these were early succession annuals or short-lived perennials. The grassy vegetation most abundant here was Japanese brome, windmill grass (Chloris verticillata), sand dropseed (Sporobolus cryptandrus), witch grass (Panicum capillare), stink grass (Eragrostis cilianensis) and green foxtail. The only perennial grasses found on the area were located in the rows of trees where they were not in danger of being killed by tillage. Side-oats grama, switch grass and marsh muhly (Muhlenbergia racemosa) were the only perennial grasses recorded in the trapping area.

Sixteen species of forbs were identified on the area. The species found most abundantly over the area were fireweed, mule's tail, annual sunflower and Russian thistle (Salsola pestifer).

Moderately Grazed Pasture

The moderately grazed pasture was an area of approximately 26 acres lying one mile southwest of Hays, Kansas. The legal description is the northwest one-fourth of the north one-half of section 23, T-13S, R-18W.

This pasture is a part of the Fort Hays Kansas State College farm and is used during the spring, summer and fall as a grazing area for the college dairy cattle. In the spring of 1941 the pasture was reseeded to a mixture of native grasses. The draw which ran diagonally through the trapping area was seeded to a mixture of 30 pounds of western wheatgrass, 20 pounds of Canada wild rye, 10 pounds of switch grass and five pounds of plains bristlegrass (Setaria macrostachya). This was sown at the rate of 10 pounds per acre. The north and south hillsides were seeded to Hereford Texas strain blue grama at the rate of 10 pounds per acre.

The trapping plot located within the moderately grazed pasture was 500 feet long and 250 feet wide, taking in an area of approximately 2.87 acres. Fifty live traps were set in a grid with 50-foot intervals (Fig. 13).

Within the trapping area three communities were identified on the basis of their grassy composition. These were mixed-grass, western wheatgrass and weed communities.

The mixed-grass community was located on the north and south-facing slopes and made up approximately 1.84 acres (Fig. 14). The basal cover of the mixed-grass community was 29.0 per cent. Blue grama, with a frequency of 61.7 per cent, made up 53.3 per cent of the composition. Buffalo grass, having a frequency of 15.0 per cent, made up 20.1 per cent of the composition. Other grasses of importance, but making up only a small part of the composition, were switch grass, side-oats grama, western wheatgrass and windmill grass.

A total of 36 species of non-grassy vegetation was recorded on this area. The most common species were western ragweed, many-flowered aster,

Fig. 13. View of the moderately grazed pasture trapping area, taken from the north end. Short grass, buffalo grass (Buchloe dactyloides) and blue grama (Bouteloua gracilis), is dominant in the foreground. The forb visible in the foreground is many-flowered aster (Aster multiflorus). The weedy draw can be seen bisecting the trapping area.

Fig. 14. View of the mixed-grass community, looking west. Side-oats grama (Bouteloua curtipendula), blue grama (Bouteloua gracilis) and buffalo grass (Buchloe dactyloides) are visible in the foreground. A patch of switch grass (Panicum virgatum) can be seen in the upper right-hand corner.

gumweed (Grindelia squarrosa), Kansas sage (Artemisia kansana) and foetid marigold (Boebera papposa).

The western wheatgrass community occupied 0.80 acres across the bottom of the north and south-facing slopes, bordering the draw (Fig. 15). Basal cover in this community was 16.6 per cent. Western wheatgrass had a frequency of 63.8 per cent and made up 62.4 per cent of the composition. Another important grass in this community was blue grama, which made up 21.8 per cent of the composition and had a frequency of 21.8 per cent. Other grasses of importance, but of lesser composition, were switch grass and side-oats grama.

Twenty-six forbs were recorded in this community. Many-flowered aster, Kansas sage, western ragweed and false prairie boneset (Kuhnia glutinosa) were found most commonly in this community.

The draw which bisected the trapline made up the weed community (Fig. 16). The basal cover was 19.2 per cent, and only two grasses made up the grassy composition. However, the weedy annual Japanese brome was abundant throughout this community. Switch grass, with a frequency of 50.0 per cent, made up 64.6 per cent of the composition and western wheatgrass made up 35.4 per cent of the composition, with a frequency of 46.7 per cent.

A total of 19 species of non-grassy vegetation was recorded on this area. Of these 19, six were found most common. These were western ragweed, giant ragweed, annual sunflower, fireweed, slender-leafed ground cherry (Physalis lanceolata) and tall dock.

Fig. 15. Western wheatgrass community located near the bottom of a north-facing slope. The weed community can be seen in the upper left-hand corner.

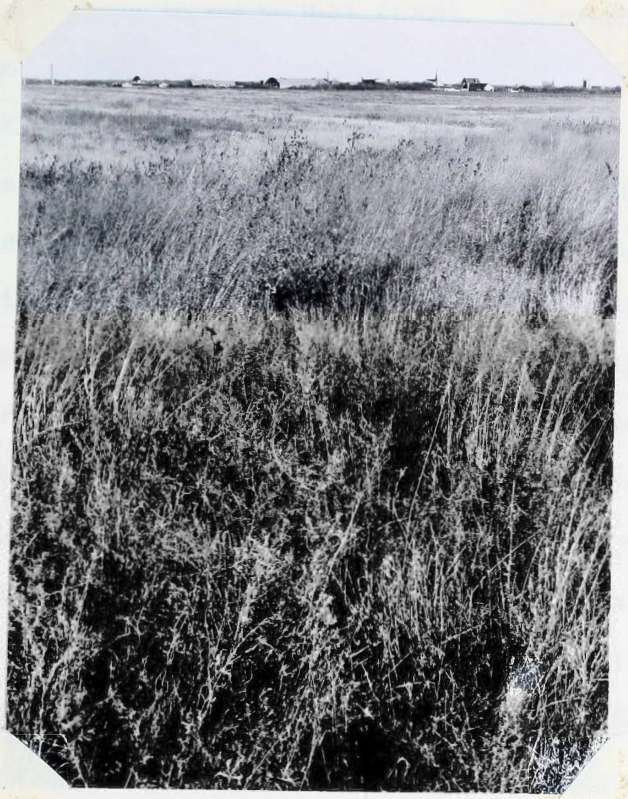

Fig. 16. Weed community lying in the draw which bisected the trapping area. Switch grass (Panicum virgatum) can be seen throughout the area. The weeds visible above the switch grass are giant ragweed (Ambrosia trifida). The western wheatgrass community can be seen on the upper left-hand side of the photograph.

RESULTS

According to Hall (1955) there are 16 species of small rodents in Ellis County. Eight species were recorded in this investigation. Of these eight species seven were listed by Hall (1955). The remaining species, white-footed mouse (Peromyscus leucopus aridulus), was recorded for the first time in Ellis County (Frydendall, 1960).

During the period of this investigation, July 1959 through May 1960, 443 individuals were captured 946 times (Table IV). Of the four research areas, the relict area was the most productive, having a total of 227 individuals captured 513 times, followed by the moderately grazed pasture, where there were 98 individuals captured 267 times. On the streambank association there were recorded 68 individuals captured 98 times and in the shelterbelt there were 50 individuals captured a total of 68 times.

In the relict area the small mammals were found to be most abundant in July, decreasing during the winter months and rising again in the spring (Fig. 17). The moderately grazed pasture had a more constant abundance of small mammals with minor fluctuations. However, the greatest abundance was in July, decreasing somewhat during the winter months (Fig. 18). The streambank trapping area had the greatest abundance in July, decreasing in abundance during the following months (Fig. 19). There was very little increase of abundance in the spring, possibly due to the long length of time (from the middle of January to the last of March) when the snow remained drifted on the area. With this snow, food supplies were probably limited, causing considerable loss of individuals. The only species which was captured in significant numbers after the melting of the snow was the white-

Table IV. Species and number of small mammals captured on the four live traplines between July 1959 and May 1960 inclusive. I represents the number of individuals and C represents the number of captures.

	Relict area		Moderately grazed pasture		Shelter-belt		Stream-bank			
Species	I	C	I	C	I	C	I	C	I	C
Deer mouse	72	171	6	10	1	1			79	182
Western harvest mouse	29	45	32	39	6	7			67	91
Cotton rat	97	224	26	98	11	20			134	342
Ground squirrel	9	32	22	104	2	2			33	138
Prairie vole	18	28	11	15			15	24	44	67
White-footed mouse					14	17	36	54	50	71
Pocket mouse	2	13					1	1	3	14
House mouse			1	1	16	21	16	19	33	41
TOTALS	227	513	98	267	50	68	68	98	443	946

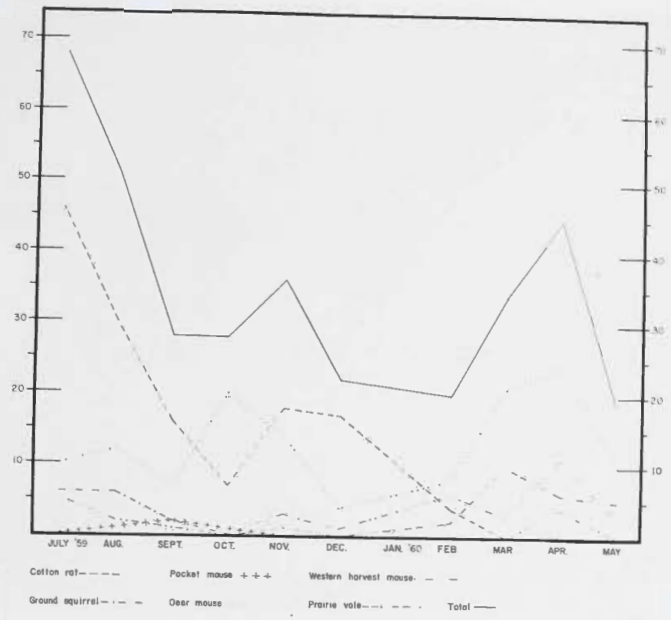

Fig. 17. Monthly abundance of small mammals on the relict area trapping plot. There was no trapping in January.

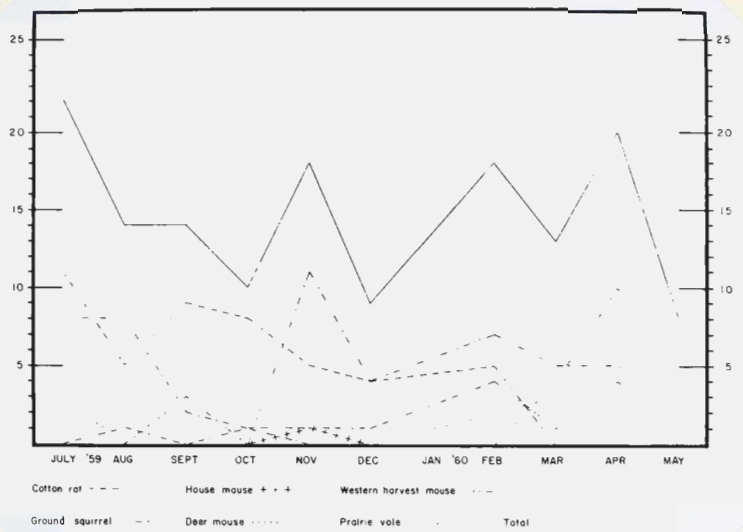

Fig. 18. Monthly abundance of small mammals on the moderately grazed pasture trapping area. There was no trapping in January.

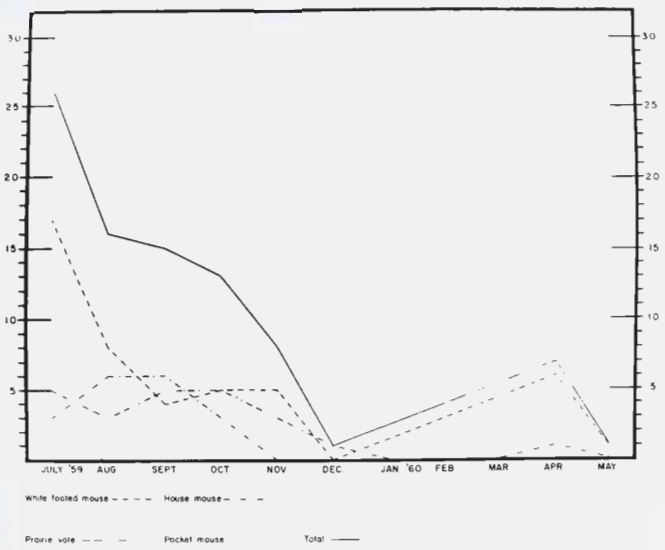

Fig. 19. Monthly abundance of small mammals on the streambank association trapping area. There was no trapping in January, February or March.

footed mouse. The shelterbelt followed the same pattern as did the streambank association. The greatest abundance of small mammals was found in July, decreasing during the following months and showing no spring increase (Fig. 20). The failure of a spring increase was possibly due to the same factor as was described for the streambank trapping area.

On the four trapping areas it was found that there was a decrease in abundance from April to May (Figures 17, 18, 19 and 20). A possible explanation for this is that there was an increase in succulent vegetation for food which decreased bait acceptance during the May trapping period.

Seasonal community preference was interpreted for those species captured on the relict area and moderately grazed pasture traplines (Tables V and VI). Explanation for interpreting these preferences can be found in the methods section and various species preferences will be explained throughout this section.

Due to the small number of individuals being recaptured a significant number of times, meager information was tabulated on seasonal movements. However, those individuals captured four or more times, during the days of each month that the traps were in operation, were used to interpret seasonal movements. Distances for these movements were calculated by using the Pythagorean theorem, finding maximum distance moved between the two most distant points of capture. Table VII gives seasonal movements of those species of which individuals were recaptured enough times to obtain significant results.

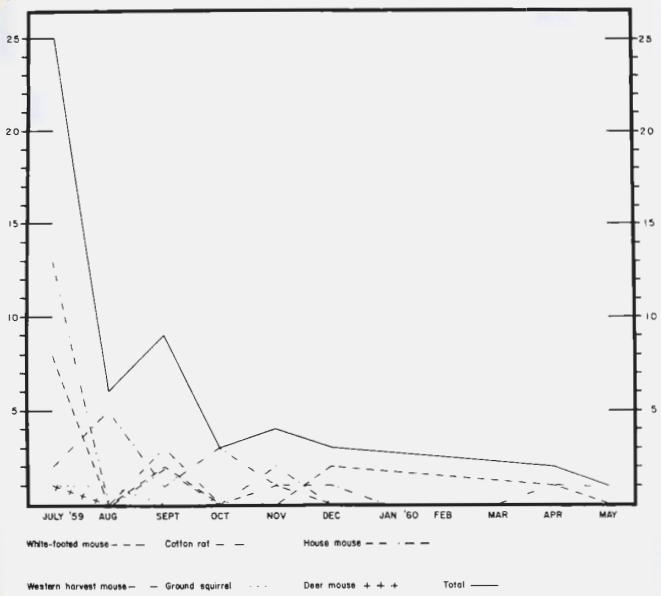

Fig. 20. Monthly abundance of small mammals on the shelterbelt trapping area. There was no trapping in January, February or March.

Table V. Community preference of small mammals of the relict area. Positive signs indicate an abundance greater than the expected from a hypothesis of random distribution and negative signs represent an abundance less than expected. Differences were made only when they were significant at the five per cent level of confidence. Seasons are shown as: sp - spring; s - summer; f - fall; and w - winter.

Community	Big bluestem				Little bluestem				Western wheatgrass				Mixed grass				Weed			
Season	sp	s	f	w	sp	s	f	w	sp	s	f	w	sp	s	f	w	sp	s	f	w
Species																				
Deer mouse						+	-				-				+			-	-	
Western harvest mouse										+				-				+	+	+
Cotton rat	-	-	-							+	+			-	-	-		+	+	+
Ground squirrel														+						
Prairie vole		+							+									-		
Pocket mouse	No Preference																			

Table VI. Community preference of small mammals of the moderately grazed pasture. Positive signs indicate an abundance greater than the expected from a hypothesis of random distribution and negative signs represent an abundance less than expected. Differences were made only when they were significant at the five per cent level of confidence. Seasons are shown as: sp - spring; s - summer; f - fall; and w - winter.

Community	Mixed grass				Western wheatgrass				Weed			
Season	sp	s	f	w	sp	s	f	w	sp	s	f	w
Species												
Western harvest mouse	-		-	-	+		+	-				+
Deer mouse		-			-	+			-			
Cotton rat		-	-	-		-	-	-		+	+	+
Prairie vole	-				+							
Ground squirrel						-				-		
House mouse	No Preference											

Table VII. Seasonal average maximum distance moved of species captured on the four ecological areas. Distances are given in feet. Seasons are shown as: sp - spring; s - summer; f - fall; and w - winter. "A" is the average maximum distance moved and "B" is the number of individuals.

Area	Relict area				Moderately Grazed Pasture				Shelterbelt				Streambank Association			
Season	sp	s	f	w	sp	s	f	w	sp	s	f	w	sp	s	f	w
Species																
Deer mouse	135	143	173													A
	4	3	3													B
Western harvest mouse	61															A
	2															B
Cotton rat		95	144	115	112	133	132	112		70	25					A
		15	9	5	1	4	4	1		3	1					B
White-footed mouse										150				45		A
										1				4		B
Ground squirrel		175			239	156	71									A
		5			5	9	1									B
Prairie vole														25		A
														1		B
Pocket mouse		183	158													A
		1	1													B
House mouse										50						A
										1						B

Prairie Deer Mouse

(Peromyscus maniculatus luteus, Wagner)

The prairie deer mouse (Peromyscus maniculatus luteus) was abundant on the relict area except in September, December and February. However, it was captured in every month of the investigation. This was in accordance with findings of Hall (1955), showing that deer mice are active throughout the year. During the study period 72 individuals were captured 171 times (Table IV). Black (1937), Brown (1946) and Cockrum (1952) commented on the abundance and wide distribution of this species in Kansas. The late summer slump in September probably was due to the increase in insects for food creating a reluctance to enter traps (Fitch, 1954). In addition to insects the deer mouse eats many seeds, which are more abundant in the fall than in the summer. This may also be of importance in accounting for the late summer drop of abundance (Martin, 1960). According to Jameson (1955) a decline in an abundance of deer mice is believed to be due to a lack of food and non-breeding, rather than mortality. This could be a possible explanation for the December and February decreases in abundance.

In the relict area the deer mouse showed a summer preference for the little bluestem community and a fall preference for the mixed-grass community (Table V). Negative preference was shown toward the western wheatgrass and little bluestem communities during the fall and toward the weed community in the spring and summer. In all other cases no preference was shown.

In the spring, on the relict area trapping plot, the average maximum distance traveled by four individuals was 135 feet (Table VII). The greatest distance moved by one individual was 300 feet and the shortest distance

was 50 feet. During the summer the average maximum distance traveled was 143 feet. Here the maximum distance traveled by one individual was 250 feet and the shortest distance was 50 feet. The average maximum distance traveled by three individuals in the fall was 173 feet. One individual moved a maximum of 269 feet and the shortest individual movement was 150 feet. No individuals were captured a sufficient number of times to calculate a winter movement.

Very few deer mice were taken on the moderately grazed pasture trapping area. Here individuals were captured only in July, February, March and April (Fig. 18). During the study period only six individuals were captured 10 times (Table IV). No explanation could be found for this small number captured except possibly reluctance to enter the traps. Not enough captures were made to calculate their movements for any of the four seasons.

In the shelterbelt trapping area only one individual was captured one time and none was captured on the streambank trapping area (Table IV). The one individual taken in the shelterbelt was captured in an end trap, just across the road from a small pasture. This individual could possibly have ventured into the trapping area and then back out again.

The lack of deer mice in the wooded areas and their abundance in the two prairie habitats agrees with Dice (1923). He states that the deer mouse is common on the prairie and on rocky ground.

Hispid Cotton Rat

(Sigmodon hispidus texianus, Say & Ord)

The hispid cotton rat (Sigmodon hispidus texianus) was the species which was captured the greatest total number of times. On all four

trapping areas a total of 134 individuals was captured 342 times (Table IV).

The cotton rat has been extending its range into Kansas for several years. According to Cockrum (1948) this species was first recorded in Kansas by Baily in 1902. Since then they have been moving northward. Rinker (1942) stated that the extent and cause of this movement is unknown at present. The last few years before 1942 were a period of higher mean temperature and decreased rainfall in this area. These changes and other conditions resulting from it might possibly allow an extension of the range of this species into areas where formerly a favorable habitat was not found. The cotton rat was first captured near Hays, Kansas in 1949 (Martin, 1960).

Cotton rats were abundant on the relict area and moderately grazed pasture and some were found in the shelterbelt until deep snow covered the trapping areas from February 20 to March 26. After February 20 no cotton rats were taken. These findings were in accordance with Martin (1960) where he stated a heavy cover of snow would almost completely deplete the cotton rat population.

On the relict area 97 individuals were captured 224 times (Table IV). They were most abundant in July and dropped off during the following months (Fig. 17). They continued to decrease through October. Then, during November and December their abundance rose slightly, dropping off again in February. None were captured from February to the end of the investigation.

The cotton rat showed a preference for the western wheatgrass community in the summer and fall and for the weed community in all four seasons (Table V). Negative preference was shown by the cotton rat toward the big bluestem community in the spring, summer and fall and no preference was shown toward this community in the winter. In the mixed-grass community negative preference was shown in the summer, fall and winter but no preference was shown in the spring. No preference was shown toward the little bluestem community in any of the four seasons.

On the relict area trapping plot no individuals were captured a sufficient number of times to calculate their movement. During the summer the average maximum move of 15 individuals was 95 feet. The maximum move of one individual was 212 feet and the minimum was 50 feet. In the fall the average maximum move of nine individuals was 144 feet. Here the greatest individual move was 403 feet and the shortest was 50 feet. The average maximum move during the winter was 115 feet, recorded from five individuals. The greatest individual move recorded was 206 feet and the shortest was 71 feet.

On the moderately grazed pasture 26 individuals were captured 98 times (Table IV). They were most abundant in July and dropped off during the following months (Fig. 18). The last captures were made in February and from then until the end of the investigation no individuals were taken (Fig. 18).

Preference was shown for the weed community during the summer, fall and winter in the moderately grazed pasture (Table VI). Negative preference was shown toward the mixed-grass and western wheatgrass communities

during the same three seasons. No preference was shown toward any of the three communities during spring.

The average maximum distance traveled was 112 feet during the spring (Table VII). This was from only one individual. The average maximum distance traveled by four individuals during the summer was 133 feet (Table VII). The maximum distance was 212 feet and the minimum was 71 feet. During the fall months the average maximum distance traveled was 132 feet, calculated from four individuals (Table VII). The greatest distance covered by an individual was 180 feet and the shortest was 71 feet. During the winter months only one individual was captured a sufficient number of times to calculate its movements. This individual moved a distance of 112 feet (Table VII).

In the shelterbelt trapping area 11 cotton rats were captured 20 times (Table IV). They showed the greatest abundance in August and fluctuated slightly from then until December (Fig. 20). No individuals were captured from December through the remainder of the investigation. The lack of captures in February was possibly due to the drifting of the snow on the area in January, which remained there until the end of March (Table II).

During the summer three individuals were captured enough times to calculate their movements. The average maximum distance moved during this season was 70 feet. The greatest distance moved by an individual was 103 feet and the shortest distance was 50 feet. In the fall only one individual was captured enough times to calculate its movements. Its maximum move was 25 feet.

Average maximum movements in the shelterbelt were considerably shorter than those recorded for the two prairie habitats. This was possibly due to the narrowness of the trapping area.

No cotton rats were taken on the streambank trapping area (Table IV).

The findings on the movements were somewhat in accordance with Stickel and Stickel (1949). They recorded ten adult males and all juvenile males had travel records of less than 200 feet. However, two males moved more than 200 feet (one 242 and another 279 feet). The maximum distance recorded for a female cotton rat was 94 feet.

Western Harvest Mouse

(Reithrodontomys megalotis duchei, Baird)

The western harvest mouse (Reithrodontomys megalotis duchei) was represented in the relict area by 29 individuals being captured 45 times (Table IV). The individuals captured were most abundant in the spring, which was probably due to bait acceptance rather than density (Fitch, 1958). During the fall, weed seed probably furnished sufficient food.

The harvest mouse showed a preference toward the weed community during the spring, summer and fall (Table V). Preference was also shown for the western wheatgrass community during the summer. Negative preference was shown toward the mixed-grass community during the summer. Negative preference was shown toward the mixed-grass community during the summer. No preference was indicated toward the big bluestem and little bluestem communities.

Spring was the only season when individuals were captured a sufficient number of times to calculate their movements. The average maximum distance

moved by two individuals was 61 feet. The greatest distance moved by an individual was 71 feet and the shortest distance was 50 feet.

On the moderately grazed pasture trapping area, 32 individuals were captured 39 times (Table IV). Abundance was low from July through October, but in November their abundance reached a peak, then dropped off slightly and remained somewhat constant (Fig. 18). This type of cycle was possibly due to bait acceptance rather than density (Fitch, 1958). During the summer and fall they seemed less attracted to bait, probably because of the abundance of preferred natural foods.

During the spring and fall the harvest mice showed a preference toward the western wheatgrass community (Table VI). A preference was shown for the weed community during the winter. This was possibly due to the added protection created by the larger vegetation and a greater amount of food in this community. A negative preference was shown toward the western wheatgrass and weed communities in the spring and the mixed-grass community in the summer.

No individuals were captured a sufficient number of times to calculate their movements.

On the shelterbelt trapping area six harvest mice were captured seven times. These findings seem to agree with others (Black, 1937; Fitch, 1958; and Hall, 1955) that the harvest mouse prefers the prairie habitats.

No harvest mice were taken on the streambank trapping area (Table IV).

Prairie Vole

(*Microtus ochrogaster haydeni*, Wagner)

The prairie vole was captured on all the ecological habitats under in-

vestigation except the shelterbelt. On these three areas a total of 44 individuals were captured 67 times (Table IV). Populations of the deer mouse were more adaptable to changes in environmental conditions and fluctuated less violently than voles (Jameson, 1955). Such results were supported for these two species in the study areas. One possible factor in regulating the abundance of voles was the cotton rat population, which depressed the abundance of voles (Martin, 1960).

On the relict area, 18 individuals were captured 28 times (Table IV). No individuals were captured on the area until November (Fig. 17). Before this, none had been captured on this area since September 1957 (Martin, 1960). The prairie vole did not reach its peak in abundance until March, after the disappearance of the cotton rats. From this time until the end of the investigation their abundance remained fairly constant.

On the relict area the prairie vole indicated a spring preference for the western wheatgrass community, which was previously reported by Martin (1960) (Table V). A preference for the big bluestem community was shown for the summer. Negative preference was shown toward the weed community during the spring and no preference was shown for either the mixed-grass or little bluestem communities.

No individuals were captured a sufficient number of times to calculate the prairie vole's movements on the relict area trapping plot.

Eleven individuals captured 15 times were recorded for the moderately grazed pasture trapline (Table IV). Individuals were captured in all months of trapping except July and September. However, the greatest abundances were not recorded until spring, when the cotton rat population was low or depleted (Fig. 18).

In the three communities of the moderately grazed pasture the prairie vole indicated a spring preference for the western wheatgrass community and a spring negative preference toward the mixed-grass community (Table VI). No preference was shown for the weed community.

No individuals were captured enough times to make significant calculations of the movements on the moderately grazed pasture.

On the streambank trapping area 15 individuals were captured 24 times (Table IV). Individuals were captured from July through December, with very little fluctuation in abundance (Fig. 19). After December no individuals were taken. This could have been due to the snow remaining on the area from mid-January until the latter part of March (Table II). This snow could have almost depleted the population of prairie voles.

Only one individual was captured enough times to calculate its movements. This individual traveled a maximum of 25 feet (Table VII).

Thirteen-lined Ground Squirrel

(Spermophilus tridecemlineatus arenicola, Mitchell)

The thirteen-lined ground squirrel (Spermophilus tridecemlineatus arenicola) was a prominent part of the summer fauna, going into hibernation during the winter months. Ground squirrels were captured on all of the four study plots, except the streambank. A total of 33 individuals were captured 138 times (Table IV).

On the relict area trapping plot, ground squirrels were most abundant in the fall (Fig. 17). They disappeared in October and did not reappear until April. No individuals were captured in May, the last month of the

investigation, and no explanation for their disappearance, except reluctance to enter the traps, could be found.

The ground squirrel showed a preference for the mixed-grass community on the relict area (Table V). These findings are in accordance with Martin (1960).

Summer was the only time when individuals were captured enough times to obtain significant data on their movements. Five individuals moved an average maximum distance of 175 feet (Table VII). The greatest distance moved by any individual was 364 feet and the shortest distance was 50 feet.

On the moderately grazed pasture, 22 individuals were captured 104 times (Table IV). As in the relict area, they had a high abundance in the summer and fall (Fig. 18). Individuals disappeared from the trapping area in November and were not captured again until March. Their greatest abundance for the time of the investigation was in April.

No positive community preference was found for the ground squirrel on the moderately grazed pasture. However, it was noticed that the largest percentage of the individuals were captured in the mixed-grass community. A summer negative preference was found toward the western wheatgrass and weed communities (Table VI).

During the spring the average maximum distance move of five individuals was 239 feet (Table VII). The greatest move by one individual was 474 feet and the shortest distance traveled was 71 feet. The average maximum distance moved in summer, calculated from nine individuals, was 156 feet. The maximum distance moved by one individual was 292 feet and the minimum was 50 feet. During the fall only one individual was captured enough times to calculate significant data. This individual traveled a maximum of 71 feet.

On the shelterbelt study area only two individuals were captured two times (Table IV). These individuals possibly strayed into the shelterbelt from the prairie vegetation located on the east side.

White-footed Mouse

(Peromyscus leucopus aridulus, Rafinesque)

The white-footed mouse was captured only along the streams and in wooded areas. This is in agreement with numerous investigators (e.g., Hall and Kelson, 1959; Sprague, 1939; Hibbard, 1944). Hibbard (1937) seems to believe this is due to the more humid environment in these habitats. However, Dice (1922) found the white-footed mouse in the forest and the prairie deer mouse in the open fields of the same area but failed to find any differences in their requirements for water, food, temperature or air humidity sufficient to be the basis of these habitat preferences.

In agreement with Fitch (1958), it was found that these mice seem to have a very good sense of direction. When individuals were released from the live trap they seemed to go directly to shelter through a familiar route. One individual when released scampered across the ground directly to an American elm tree, climbed about two feet up the trunk and disappeared into a small hole.

White-footed mice were captured only on the streambank and shelterbelt study areas. On these two areas a total of 50 individuals were captured 71 times (Table IV).

On the shelterbelt trapping area 14 individuals were captured 17 times (Table IV). Only one individual was captured enough times to calculate its movements. These captures were made for the summer season and the maximum distance moved was 150 feet (Table VII).

On the streambank study plot 36 individuals were captured 54 times (Table IV). The average maximum distance moved by four animals was 45 feet (Table VII). The greatest distance moved by one individual was 56 feet and the shortest distance was 25 feet.

Coarse-haired Pocket Mouse

(Perognathus hispidus paradoxus, Baird)

The coarse-haired pocket mouse (Perognathus hispidus paradoxus) was captured only on the relict area study plot and the streambank study area. Only one individual was captured one time on the streambank study area (Table IV). This individual was captured in a trap located in a weedy area near a cultivated field.

On the relict area study plot two individuals were captured 13 times (Table IV). These captures were all made in August, September and October. There was no community preference found for this species.

All movements were recorded from one individual. In the summer season it was found that the maximum distance moved was 183 feet and in the fall season the maximum distance traveled was 158 feet (Table VII).

House Mouse

(Mus musculus, Linnaeus)

The house mouse (Mus musculus) was captured in all ecological habitats except the relict area study plot. Thirty-three house mice were captured 41 times (Table IV). On the moderately grazed pasture trapline only one individual was captured once (Table IV). This individual was possibly carried in by a vehicle or in some other manner and will not be considered further.

On the shelterbelt study area 16 house mice were captured 21 times (Table IV). They were most abundant in July and fluctuated considerably from then until November, when the last individuals were taken (Fig. 20). These individuals could have moved from the shelterbelt to the college farm machine sheds, which were some 500 feet away. This is in agreement with Fitch (1958), where he states that a house mouse was captured in a building, carried 860 feet away and released. The next day the individual was recaptured in the same building. Another explanation for this depletion in population which is also in agreement with Fitch (1958) is that they were killed by the severe winter weather.

Only one house mouse was captured a sufficient number of times to calculate movements. This individual was captured in the summer season and traveled a maximum distance of 50 feet.

On the streambank study area 16 individuals were captured 19 times (Table IV). Here the house mouse reached its peak in abundance during August and September (Fig. 19). The last individuals were taken in October and there were no specimens captured again until April. Probably the cold weather and heavy cover of snow during the winter months almost completely depleted the area of the house mouse.

SUMMARY AND CONCLUSION

The primary purpose of this investigation was to study the seasonal changes of distribution, activity and species composition of small mammals of four different ecological sites near Hays, Kansas. These habitats were: a non-grazed native prairie (relict area); a moderately grazed pasture; a shelterbelt; and a streambank association.

Live traps were used in this investigation so that individuals could be marked for identification, released and recaptured to obtain the data desired.

The use of climatological data was found to be very helpful in explaining some of the results obtained. The large amount of snow received during the winter and spring and the length of time which this snow remained on the ground seemed to have considerable effects upon the abundance of some of the small mammals.

In all four of the ecological areas under investigation it was found that the small mammals were most abundant during the summer season. On all areas except the moderately grazed pasture there was a decrease in the abundance of the small mammal populations during the fall and a low was reached during the winter and early spring (February). The populations of the moderately grazed pasture remained more or less constant, with only minor fluctuations, throughout all the four seasons. A possible reason for this was the increase in the abundance of western harvest mice during the winter and spring months. This increase was probably due to bait acceptance rather than population density (Fitch, 1958). On the shelterbelt and streambank trapping areas there was no great spring increase in the abundance of the small mammals from the winter low. The snow drifts which re-

mained on the areas from the middle of January to the last of March possibly depleted much of the small mammal populations.

It was found that the cotton rat was most active during the summer, decreased in abundance during the fall and winter and disappeared completely in the early spring. The disappearance of the cotton rat in early spring was probably due to the snow remaining on the ground for a great length of time during February and March. These findings were in agreement with Martin (1960).

In general, the cotton rat seemed to prefer the weed communities.

On the relict area the prairie deer mouse was active throughout all seasons. However, they were found to be most abundant during the fall and spring seasons. The number of captures was small on the moderately grazed pasture study plot. Here the prairie deer mouse was most active during the spring and summer seasons. Only one prairie deer mouse was captured on the shelterbelt study area and none were taken on the streambank association.

Summer preference was indicated by the prairie deer mouse for the little bluestem community of the relict area and western wheatgrass community of the moderately grazed pasture.

The prairie vole was captured during all seasons on the moderately grazed pasture study area, but were most active in the spring. Prairie voles were not taken in the relict area until November and they reached their peak of abundance during the spring. A possible reason for the absence and low abundance of the prairie vole during the summer, fall and winter, with an increase of the population in the spring, could be the presence of the cotton rat. Martin (1960) found that whenever the cotton rat population was high the prairie vole population was low and with the disap-

pearance of the cotton rat the prairie vole population increased. On the streambank study area the prairie vole was most abundant during the summer and fall and decreased during the winter. No individuals were captured in the spring.

The prairie vole indicated a spring preference for the western wheatgrass community on both prairie habitats and a summer preference for the big bluestem community on the relict area.

The western harvest mouse was found to be active throughout all seasons. On the relict area and moderately grazed pasture they were found to be most abundant in the spring of the year. On the shelterbelt study area few individuals were captured and no conclusion could be made concerning the season in which they were most active.

The western harvest mouse showed a preference for the western wheatgrass community in the summer and for the weed community during the spring, summer and fall on the relict area study plot. In the moderately grazed pasture a preference was indicated toward the western wheatgrass community in the spring and fall and the weed community during the winter.

The ground squirrel, being a hibernating mammal, was most active on the two prairie habitats during the spring and summer. No individuals were captured during the winter season. On the shelterbelt study area only two individuals were captured, so no peak of activity could be indicated for the ground squirrel in this area.

On the relict area study plot the ground squirrel showed a preference for the mixed-grass community during the summer, but on the moderately grazed pasture no preference was shown.

Only three pocket mice, two on the relict area and one on the streambank association, were captured and no conclusion could be made from this meager information.

The white-footed mouse was captured on only the streambank and shelterbelt study areas.

On the streambank study area the white-footed mouse was the most abundant small mammal. They were found to be most active in the summer, decreasing during the fall and winter and increasing during the spring. On the shelterbelt study plot the white-footed mouse was most active during the summer months, decreasing in abundance during the fall and winter and failing to show a spring increase in abundance.

The house mouse was captured on all four ecological areas except the relict area study plot. Only one individual was taken in the moderately grazed pasture. On the shelterbelt study area the house mouse was the most abundant small mammal. This was possibly due to the shelterbelt being located near the college farm maintenance buildings. They would venture from the buildings to the shelterbelt. In this area the house mouse was most abundant during the summer and decreased in the fall.

In the streambank association the house mouse was most active during the summer. The last individuals taken were captured in October and none were taken again until April, when only one individual was captured. No spring increase was shown for the house mouse.

Only meager information on seasonal movements was found and no attempt will be made to conclude the findings. This limited information could possibly be helpful to other investigators interested in this type of study.

To obtain a comparison of seasonal movements by small mammals a greater length of time would be needed than was used for this study.

LITERATURE CITED

Albertson, F. W. 1937. Ecology of mixed prairie in west central Kansas. Ecol. Monog., 7:481-547.

_____. 1938. Prairie studies in west central Kansas. Trans. Kansas Acad. Sci., 41:77-83.

_____. 1939. Prairie studies in west central Kansas. Trans. Kansas Acad. Sci., 42:97-107.

_____. 1943. Prairie studies in west central Kansas. Trans. Kansas Acad. Sci., 46:81-84.

_____. 1945. Prairie studies in west central Kansas. Trans. Kansas Acad. Sci., 47:405-414.

_____ and J. E. Weaver. 1942. History of the native vegetation of western Kansas during seven years of continuous drought. Ecol. Monog., 12:23-51.

Allen, Paul. 1940. Kansas mammals. Kansas State Teacher's College of Emporia, Bull. Info., 20:7-62.

Black, J. D. 1937. Mammals of Kansas. Kansas State Board Agric., 30th Biennial Rep., 1935-1936:116-217.

Brown, H. Leo. 1945. Evidence of winter breeding of Peromyscus. Ecol. 26:308-309.

_____. 1946. Rodent activity in a mixed prairie near Hays, Kansas. Trans. Kansas Acad. Sci., 48:448-456.

_____. 1947. Coactions of jackrabbit, cottontail, and vegetation in a mixed prairie. Trans. Kansas Acad. Sci., 50:28-44.

Clarke, S. E., J. A. Campbell and J. B. Campbell. 1942. An ecological and grazing capacity study of the native grass pastures in southern Alberta, Saskatchewan and Manitoba. Dom. Canada Dept. Agric. Tech. Bull., 44.

Cockrum, E. Lendell. 1947. Effectiveness of live trap vs. snap traps. Jour. Mamm., 28:186.

_____. 1948. Distribution of the cotton rat in Kansas. Trans. Kansas Acad. Sci., 51:306-312.

_____. 1952. Mammals of Kansas. Univ. Kansas, Mus. Nat Hist. Publ., 7:1-103.

Coupland, Robert T. 1950. Ecology of mixed prairie in Canada. Ecol. Monog., 20:271-315.

Dice, Lee R. 1922. Some factors affecting the distribution of the prairie vole, forest deer mouse and prairie deer mouse. Ecol., 3:29-47.

_____. 1923. Notes on some small mammals of Riley County Kansas. Jour. Mamm., 4:107-112.

_____. 1931. Methods of indicating the abundance of mammals. Jour. Mamm., 12:381.

Dickens, Albert, Margaret E. Whittemore, Chas. A. Scott and Frank C. Gates. 1928. Trees in Kansas. Rept. of the Kansas State Board of Agric., Kansas State Printing Plant, Topeka, Kansas, 47:1-372.

Fitch, Henry S. 1950. A new style live trap for small mammals. Jour. Mamm., 31:364-365.

_____. 1952. The University of Kansas Natural History Reservation. Univ. Kansas, Mus. Nat. Hist., Misc. Pulb., 4:1-38.

_____. 1954. Seasonal acceptance of bait by small mammals. Jour. Mamm., 35:39-48.

_____. 1958. Home ranges, territories, and seasonal movements of vertebrates of the natural history reservation. Univ. Kansas Mus. Nat. Hist., Misc. Publ., 11:63-362.

Frydendall, Merrill. 1960. Occurrence of Peromyscus leucopus aridulus in Ellis County, Kansas, with some notes on their activities. Unpublished report.

Hall, E. Raymond. 1955. Handbook of the mammals of Kansas. Univ. Kansas Mus. Nat. Hist., Misc. Publ., 7:1-103.

_____ and Keith R. Kelson. 1959. The mammals of North America. New York, The Ronald Press Co., 2:628.

Hibbard, Claud W. 1937. Peromyscus leucopus aridulus in Kansas. Jour. Mamm., 18:101-102.

_____. 1944. A checklist of Kansas mammals. Trans. Kansas Acad. Sci., 47:61-88.

Hitchcock, A. S. and Agnes Chase. 1950. Manual of the grasses of the United States. U. S. Dept. Agric. Misc. Publ. 200 (rev.). 1051 pp.

Hopkins, H. H., F. W. Albertson and D. A. Riegel. 1952. Ecology of grassland utilization in a mixed prairie. Trans. Kansas Acad. Sci., 55:395-418.

Jameson, E. W., Jr. 1955. Some factors affecting fluctuations of Microtus and Peromyscus. Jour. Mamm., 36:206-209.

Martin, Edwin P. 1960. Distribution of native mammals among the communities of the mixed prairie. Fort Hays Studies - new series, science series no. 1:1-26.

Riegel, D. A. 1941. Some coactions of rabbits and rodents with cactus. Trans. Kansas Acad. Sci., 44:96-103.

_____. 1942. Some observations of the food coactions of rabbits in western Kansas during periods of stress. Trans. Kansas Acad. Sci., 45:369-375.

Rinker, George C. 1942. An extension of the range of the Texas cotton rat in Kansas. Jour. Mamm., 23:439.

Robb, A. D. (State Climatologist). 1959. Climatological data, Kansas. U. S. Dept. Comm. Weather Bureau, Topeka, Kansas.

_____. 1960. Climatological data, Kansas. U. S. Dept. Comm. Weather Bureau, Topeka, Kansas.

Rydberg, Per Axel. 1932. Flora of the prairies and plains of central North America. Science Press Printing Co., Lancaster, Pa., 969 pp.

Sprague, James M. 1939. Distribution of the genus Peromyscus in Kansas. Trans. Kansas Acad. Sci., 42:487-494.

Stickel, Lucille F. and William H. Stickel. 1949. A Sigmodon and Baiomys population in ungrazed and unburned Texas prairie. Jour. Mamm., 30:141-149.

Tomanek, G. W. and F. W. Albertson. 1953. Some effects of different intensities of grazing on mixed prairie near Hays, Kansas. Jour. Range Mgmt., 6:299-306.

Weaver, J. E. and F. W. Albertson. 1956. Grasslands of the Great Plains. Johnsen, Lincoln, Nebraska. 395 pp.

_____ and T. J. Fitzpatrick. 1934. The prairie. Ecol. Monog., 4:113-393.

Wooster, L. D. 1931. The present status of certain mammals in western Kansas. Trans. Kansas Acad. Sci., 34:112-113.

Wooster, L. D. 1935. Notes on effects of drought on animal populations of western Kansas. Trans. Kansas Acad. Sci., 38:351-352.

_____. 1936. The contents of owl pellets as indicators of habitat preferences of small mammals. Trans. Kansas Acad. Sci., 39:395-397.

_____. 1938. An attempt at an ecological evaluation of predators on a mixed prairie area in western Kansas. Trans. Kansas Acad. Sci., 41:387-394.

_____. 1939. An ecological evaluation of predatees on a mixed prairie area in western Kansas. Trans. Kansas Acad. Sci., 42:515-517.